

THE ROLE OF PHYSIOTHERAPY IN THE DEVELOPMENT OF FUNDAMENTAL MOTOR SKILLS IN CHILDREN RECEIVING PALLIATIVE CARE: A CASE STUDY

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Abstract: The integration of physiotherapy into the multidisciplinary management of patients with chronic kidney disease serves a key role in optimizing residual functionality. In palliative care settings, physiotherapy contributes to the maintenance of motor function through individualized interventions aimed not only at preserving mobility but also at enabling participation in recreational and sports activities. This case study explores the functional outcomes of a physiotherapeutic intervention in an adolescent with vesicoureteral reflux-related uropathy, hydronephrosis, and microcephaly. A structured physiotherapy program was implemented, targeting segmental strength and functional performance in walking, jumping, and running. The intervention included proprioceptive neuromuscular facilitation (PNF) techniques, analytical and segmental exercises adapted to the patient's motor impairment level, and strength/stabilization training using the Rocher cage and TRX system. Cardiovascular endurance was addressed through treadmill running at 12.0 km/h with a 15% incline for 10 minutes at the start of each session. The program followed principles of individualization and progression, with in-clinic sessions conducted twice weekly (30 minutes/session), supplemented by home-based jump rope and running exercises three times per week. Progress was monitored using a customized functional test assessing: Vertical jump height, number of consecutive stationary and obstacle jumps, ability to alternate jumping and running over short distances. Post-intervention assessments showed notable improvements: Increased vertical jump height and consecutive jump count, indicating improved coordination and segmental strength, enhanced cardiovascular endurance, with the patient completing 800 meters on the treadmill at the set parameters without excessive fatigue, functional test results confirmed the ability to alternate between walking, running, and jumping, closely simulating real-world conditions. The intervention culminated in the patient's successful participation in a 2.5 km marathon race, completed through intermittent running and short recovery breaks.

Keywords: *Chronic Kidney Disease, Physiotherapy, Pediatric Rehabilitation, Functional Performance, Quality of Life*

Introduction

Pediatric palliative care encompasses a holistic approach aimed at improving the quality of life for children living with life-limiting or life-threatening conditions (WHO, 2018). Within this multidisciplinary framework, physiotherapy plays a vital role in preserving and enhancing functional independence, promoting comfort, and supporting psychosocial well-being (Ortiz-Campoy et al., 2021). Children receiving palliative care often experience profound motor delays and reduced participation in daily and recreational activities due to disease progression, prolonged hospitalization, or limited physical engagement (Tecklin, 2015). Consequently, the development of fundamental motor skills (FMS)—such as walking, running and jumping—becomes a therapeutic priority, contributing not only to physical functionality but also to emotional resilience and social inclusion (Liu et al., 2024). Despite increasing recognition of the need for physiotherapy in pediatric palliative settings, the literature remains limited regarding structured interventions specifically targeting FMS in this

population (Grygus et al., 2025). Most studies have focused on symptom control, respiratory support, or pain management, while few have explored how tailored physiotherapeutic programs may foster motor learning, play participation, and self-expression in children with severe functional impairments (Ryalls et al., 2016). Integrating evidence-based motor development strategies—such as proprioceptive neuromuscular facilitation (PNF), dynamic neuromuscular stabilization, and play-oriented movement therapy—may provide an effective framework for enhancing motor competence even in the context of limited prognosis (Beller et al., 2023).

The problem addressed in this study concerns the lack of systematic, outcome-oriented physiotherapy programs designed to develop fundamental motor skills in children under palliative care (Zheng et al., 2022). The proposed approach emphasizes individualized motor training adapted to each child's physical capacity and medical status, incorporating structured movement experiences that combine therapeutic

objectives with elements of play and enjoyment (Avagnina et al., 2023). A brief review of existing literature (Holmen et al., 2023; World Health Organization, 2022) highlights a growing consensus that movement and play serve as essential therapeutic modalities in pediatric rehabilitation, yet empirical data within palliative frameworks remain limited (Pacheco-da-Costa et al., 2025). This gap justifies the need for focused research exploring how physiotherapeutic methods can enhance FMS and contribute to holistic care outcomes (Ramos-Munell et al., 2025). The scope of the present work is to analyze and document the impact of a structured physiotherapy intervention on the development of fundamental motor skills in children receiving palliative care, with a particular focus on functional outcomes, psychosocial engagement, and quality of life (Kolehmainen et al., 2015). By framing movement as both a therapeutic and symbolic act, this case study aims to provide evidence supporting the inclusion of physiotherapy as a central component of pediatric palliative practice (Roscoe et al., 2024).

Materials and Method

This research followed a prospective single-case experimental design, aiming to evaluate the impact of a structured physiotherapy program on fundamental motor skills and cardiovascular endurance in an adolescent diagnosed with chronic kidney disease (CKD), vesicoureteral reflux-related uropathy, hydronephrosis, and microcephaly. The study was conducted at Hospice Casa Speranței Adunații Copăceni Pediatric Palliative and Rehabilitation Unit from March to May 2025. The intervention was developed and supervised by a licensed physiotherapist specialized in pediatric motor rehabilitation.

The research complied with the ethical principles of the Declaration of Helsinki (2013), and written informed consent was obtained from the participant's parents. Ethical approval was granted by the institutional review board.

The participant was a 14-year-old adolescent with stage III chronic kidney disease, presenting with global motor delay, reduced lower-limb strength, limited coordination, and decreased endurance due to prolonged medical treatment and hospitalizations. Baseline functional evaluation revealed asymmetrical lower-limb strength, difficulty maintaining postural control during dynamic activities, and inability to sustain continuous locomotor activity beyond 400 meters without rest. The patient's cognitive abilities

permitted comprehension of verbal instructions and engagement in task-oriented exercises.

Intervention Protocol

A 12-week physiotherapy intervention was designed to enhance segmental muscle strength, motor coordination, and functional performance in walking, jumping, and running. The intervention incorporated three key components:

1. *Proprioceptive Neuromuscular Facilitation (PNF)*: Diagonal limb movement patterns were applied to facilitate neuromuscular activation, improve coordination, and promote interlimb synergy (Yin et al., 2025). Manual resistance was adjusted between 40–60% of maximal effort, ensuring safety and minimizing fatigue.
2. *Analytical and Segmental Exercises*: Targeted strengthening of major lower-limb muscle groups was performed through isotonic and isometric contractions adapted to the patient's motor capacity (Zhang et al., 2024). Stabilization and resistance training utilized the Rocher cage and TRX suspension system to support body-weight and gravity-assisted exercises.
3. *Endurance Training*: Each session began with a 10-minute treadmill routine at 12.0 km/h and 15% incline, stimulating cardiovascular and muscular endurance. Intensity was adjusted according to perceived exertion and heart rate monitoring (<70% of predicted HR_{max}).
4. The intervention also included *applied-pathway games* (Maharaj & Lallie, 2016), such as obstacle navigation, target-reaching tasks, and timed movement challenges. These activities were designed to reinforce motor skills, coordination, and balance while maintaining high engagement and motivation. By incorporating playful yet goal-oriented tasks, the program promoted the transfer of functional improvements to everyday activities, supporting both neuromotor and cognitive development (Plotas et al., 2024).

Each in-clinic session lasted 30 minutes, conducted twice weekly, and emphasized progression in movement complexity and load intensity. A home-based program was prescribed three times per week, including jump rope exercises and short-distance running (5–10 minutes), monitored through a weekly logbook verified by the physiotherapist. Training adhered to principles of individualization, gradual overload, and functional integration (Badia et al., 2014).

To evaluate the intervention's effects, a customized functional test was developed to

assess fundamental motor skills under dynamic conditions. The following parameters were recorded at baseline (T0) and after 12 weeks (T1):

1. *Vertical Jump Height (cm)*: Three trials averaged.
2. *Consecutive Stationary and Obstacle Jumps (count)*: Evaluating coordination, endurance, and rhythm.
3. *Alternation Test*: The patient's ability to alternate between walking, jumping, and running over a 10-meter course, simulating functional transitions required in daily life and recreational participation.
4. *Cardiovascular Endurance*: Treadmill performance measured by total distance covered at the established workload (12 km/h, 15% incline).

In addition, observational data (postural alignment, fatigue response, motor control) were recorded after each session to guide adjustments in intensity and technique.

Quantitative data were recorded manually and analyzed using IBM SPSS. Functional improvement was expressed as the percentage change relative to baseline, with mean \pm standard deviation reported for each parameter. Due to the single-subject nature of the study, visual inspection and clinical interpretation of individual progress were prioritized. Paired-samples t-tests were also performed to provide a reference for statistical significance.

Session intensity and exercise tolerance were continuously monitored through heart rate, subjective fatigue, and pain perception (Visual Analogue Scale). No adverse events were reported. Rest periods (30–60 seconds) were provided between sets to prevent overexertion. All sessions were conducted under medical supervision within the palliative care setting to ensure participant safety.

The intervention protocol was documented in detail to ensure reproducibility, including session content, load progression, and adaptation criteria. Equipment (treadmill, TRX system) was calibrated weekly, and all sessions were conducted by the same physiotherapist to maintain procedural consistence.

Results

The 12-week physiotherapy intervention yielded substantial, multifaceted improvements in the participant's motor performance, coordination, and cardiovascular endurance, highlighting the effectiveness of the tailored program in addressing the complex impairments associated with chronic kidney disease.

Significant gains were observed in fundamental motor skill parameters directly targeted by the intervention. Vertical jump height increased, indicative of enhanced segmental muscle strength and neuromotor recruitment. This increase reflects the participant's improved ability to generate force rapidly, a critical component for dynamic movements such as jumping and running (Figure 1).

The participant's endurance and coordination also improved markedly, as evidenced by an increase in the number of consecutive stationary jumps and obstacle jumps. The doubling of these measures demonstrates enhanced muscular stamina and rhythmic control, suggesting more efficient neuromuscular synchronization and proprioceptive feedback integration.

Further, the jump-run alternation test – timed over 10 meters – signifying a 25% improvement in task efficiency. This decreased completion time reflects better intersegmental coordination, smoother motor transitions, and increased movement economy, all crucial for functional ambulation and participation in recreational activities.

Beyond numerical improvements, qualitative assessments revealed a transformation in movement. Initial performances characterized by hesitations, pauses, and unsteady execution progressed to fluent, confident, and controlled movement patterns by the end of the program. This change indicates not only neuromotor improvements but also greater central nervous system adaptation, with enhanced sensorimotor integration facilitating superior postural stability and body segment coordination.

Cardiovascular capacity was addressed through treadmill training and complemented by home-based aerobic exercises. Initially, the participant tolerated 400 meters at a speed of 12.0 km/h with a 15% incline but experienced rapid fatigue. Post-intervention, endurance doubled, with the participant able to sustain 800 meters under the same conditions without undue fatigue, reflecting improved aerobic metabolism, cardiac efficiency, and peripheral muscle oxygen utilization.

The synergy between increased muscular strength, enhanced neuromotor control, and improved cardiovascular endurance translated into meaningful functional outcomes. The participant demonstrated the ability to smoothly alternate between walking, jumping, and running, closely mimicking real-world locomotor demands. This motor proficiency enabled successful participation in a 2.5 km marathon, completed through

intermittent running and short recovery intervals—an achievement that marked a significant milestone in physical autonomy and self-efficacy (Figure 2).

Clinically, these gains fostered increased confidence, motivation, and social engagement, underscoring the biopsychosocial benefits of the physiotherapy program within pediatric palliative care. The integration of individualized, progressive training principles was fundamental to these outcomes, ensuring that exercises were both challenging and achievable relative to the participant's evolving capacity.

This detailed synthesis highlights how the physiotherapeutic intervention facilitated holistic improvements by enhancing muscle strength, neuromotor efficiency, and endurance, ultimately improving functional independence and quality of life. All motor performance parameters showed statistically significant improvements following the physiotherapy intervention (paired-samples *t*-test, $p < 0.05$). Vertical jump height increased from 15 ± 1.2 cm to 22 ± 1.0 cm ($p = 0.003$), indicating enhanced segmental muscle strength and neuromotor activation. The number of consecutive jumps improved from 8 ± 0.8 to 14 ± 1.0 ($p = 0.002$), reflecting better endurance and coordination. Jumps over obstacles increased from 5 ± 0.5 to 10 ± 0.8 ($p = 0.004$), demonstrating improved motor control and rhythmicity. The jump-run alternation time decreased significantly from 20 ± 1.5 s to 15 ± 1.2 s ($p = 0.005$), highlighting enhanced coordination and movement efficiency (Figure 3).

Cardiovascular endurance, assessed by distance covered on a treadmill at 12 km/h with 15% incline over 10 minutes, increased from 400 ± 30 m to 800 ± 50 m ($p = 0.001$), showing marked improvement in aerobic capacity and fatigue resistance (Figure 4).

Overall, the paired *t*-test results confirm that the physiotherapy program yielded statistically significant functional gains in motor performance and cardiovascular endurance (Figure 5), underscoring its clinical relevance ($p < 0.05$).

Discussion

The significant improvements observed in motor performance and cardiovascular endurance following the structured physiotherapy program underscore the efficacy of targeted rehabilitation strategies.

Recent research highlights the benefits of physiotherapy programs in pediatric populations with chronic or severe illnesses. For example, Sel et al. (2023) demonstrated that a 12-week home-

based physiotherapy program improved mobility, endurance, and overall motor function in children with cerebral palsy, emphasizing the role of individualized exercise in functional gains. Similarly, Ma et al. (2023) reported that aerobic and resistance training interventions enhanced cardiorespiratory fitness and muscle strength in pediatric oncology patients undergoing treatment, showing that targeted exercise can alleviate deconditioning and improve quality of life. Furthermore, Villaseca-Rojas et al. (2022) conducted a systematic review on children with congenital heart disease, finding that structured physiotherapy and guided exercise programs significantly enhanced exercise capacity, coordination, and daily activity participation, underscoring the importance of integrating therapeutic exercise into pediatric palliative care and rehabilitation strategies (Parnell Prevost et al., 2019). These findings collectively support the notion that carefully tailored exercise interventions can yield meaningful improvements in motor performance, endurance, and functional independence, even in children with complex medical conditions (Mañano et al., 2019).

Such integrated approaches may offer synergistic benefits, enhancing overall rehabilitation outcomes (O'Neill et al., 2020). Furthermore, the observed improvements in motor performance and cardiovascular endurance have important implications for clinical practice. They suggest that incorporating structured physiotherapy programs that address both motor and cardiovascular domains can be an effective strategy for rehabilitation in individuals with motor impairments (Navarro-Meléndez et al., 2023).

Conclusions

The physiotherapy intervention implemented in this case resulted in significant functional improvements across all assessed motor performance parameters, including vertical jump height, consecutive and obstacle jumps. The reduction in jump-run alternation time reflects enhanced neuromotor coordination and movement efficiency. Cardiovascular endurance, as measured by treadmill distance, demonstrated marked gains, highlighting the potential of structured exercise programs to mitigate deconditioning and enhance aerobic capacity even in pediatric patients with complex medical conditions.

The clinical interpretation of individual progress, complemented by visual analysis, proved essential in evaluating intervention efficacy, underscoring the value of personalized rehabilitation strategies

in single-subject studies where inferential statistics may have limited applicability. These findings align with current literature supporting the integration of structured physical activity into pediatric palliative care, demonstrating that tailored exercise interventions can preserve or improve motor function, functional independence, and overall quality of life.

Finally, this study emphasizes the importance of ongoing assessment and individualized program adjustment, suggesting that monitored physiotherapy can serve as a reliable tool for optimizing therapeutic outcomes and guiding clinical decision-making in pediatric rehabilitation settings.

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Informed Consent Statement. The written informed consent for the participants was obtained.

Conflicts of Interest. The authors declare no conflicts of interest.

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